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Roman Glass

By L. M. ANGUS-BUTTERWORTH
Newton Heath Glass Works, Manchester, England

ROME obtained her first glass from Egypt. There were extensive exports of Egyptian glass to Italy and Greece during the period of the native Pharaohs, and the quality of the products from the furnaces in Alexandria was fully maintained under the Ptolemies, when glass vases of considerable size and innumerable shapes were made.

While on Roman soil the manufacture of glass was to see remarkable developments, the art never made much progress in Greece, perhaps because of her magnificent tradition in the sister craft of pottery. As regards imports, Aristophanes speaks in 450 B. C. of glass vessels, which at that time were counted as being next in value to gold, in itself an indication that they were not of local manufacture. We may also recall in this connection that in the 4th century B. C. one Pausias, a celebrated Greek painter, depicted *Methē*, or "Intoxication," in the act of drinking from a transparent glass bowl which revealed her face.

There would appear to be some evidence to show that the Romans were acquainted with the glass made at an early period in the two chief cities of Phoenicia, for Herodotus and Theophrastus refer to the marvelous glassware produced at Tyre, and Pliny speaks of the glass manufactures of Sidon. Glass beads have been found also at Thebes, apparently of local make. It is probable that Rome would draw limited supplies of glass from these centres as well as from Alexandria.

Very shortly after Caesar Augustus had subdued Egypt in the year 26 B. C. he ordered that glass should form part of the tribute to be paid by the conquered. Far from being a misfortune, as might at first sight appear to be the case, this tax proved a source of wealth to the Egyptian glass industry. Glass was still largely a novelty in Rome, and her citizens called for more and more of the new productions. As a result the Egyptians devoted themselves to a very large export trade, of which they retained the monopoly for a generation. In 14 A. D., however, during the reign of Tiberius, the industry is stated by Pliny to have been established at Rome itself.

The reasons why the centre of glass-making remained in Egypt for some time after the conquest are varied. One cause was because the sand of Alexandria was considered indispensable for the finest qualities. Again inherited skill and the fact that the furnaces were already erected no doubt played their part. Roman writers record their admiration for the melting, turning, and engraving of Egyptian glass, and the Emperor Hadrian, when on a visit, was impressed with the extent to which glass manufacture was being carried on, and sent to his friend the Consul Servianus a vase of Egyptian "alosontes" or opalescent glass.

It is stated by Sauzay that the Romans were able to make rapid progress in the craft by learning it in two ways at the same time. On the one hand apprentices were sent out to the new province to learn the processes on the spot, and on the other hand Egyptian artists were attracted to Rome and provided with assistants. In a short time the Roman glass rivalled the most beautiful specimens the Egyptians had formerly brought them.

Excavations made in the ancient provinces of France have revealed that at an early date the Gauls were great rivals to the Roman glassmakers. The glasses found are similar in type and mode of manufacture to those found in Roman tombs, which supports the view that the making of glass was introduced by the conqueror in the same way as her laws, customs, manners, and other manufacturers. In like manner the Romans introduced glass-making into England.

One of the most famous pieces believed to have been made in Gaul is the Strasbourg vase. This is ornamented with a raised grill of red-colored glass and bears an inscription in green glass which includes the name of Maximianus Augustus, a Roman emperor who died at Marseilles in 310. The emperor would seem to have sent the vase to some friend in Argentoratum (Strasbourg), with whom it came to be buried.

Glass was made in the Roman Empire for a period of four centuries. During that time it came to be used for almost every purpose known to 18th century Europe. That

is to say the applications of glass as a material were hardly extended until the 19th century. Even today much Roman glass appears strikingly modern in conception, their thin mold-blown glasses, for example, looking sometimes quite like machine products. Another important point is that the Romans carried the manufacture of glass with them into every country they penetrated, from Syria and Mesopotamia to Spain and Britain. We shall see also that they became masters of many forms of glass decoration, achieving results which in certain cases have never been surpassed.

Among the extensive range of articles made in glass by the Romans may be included wine bottles (*lagenae*), urns for holding the ashes of the dead (*urnae*), dice, draughtsmen, and knucklebones (*astragali*), flasks for sacred uses (*ampullae*), two-handled vessels (*amphorae*), cameo vases (*toreumata vitri*), pillar-molded bowls and cups (*pocula*), and vials for holding perfumes, medicines, and drugs (*lacrimatorae*).

A great advance for which the credit can probably be given to the Roman glassmakers is the discovery of blown glass. This very significant departure enabled the industry to expand in a way that had been undreamt of before. As regards the exact time and place of the discovery, records are silent. We know, however, that in Egypt blown glass is not found until later Roman times, and that the Egyptians regarded the new process of glass-blowing as something unholy. Some doubt on the subject is introduced by the tradition that the glassmakers of Sidon or one of the other Phoenician coast towns had knowledge of blowing before the Romans, and that it was from them that the latter learnt it. In any case it is beyond question that the art was developed by the Romans, and that thus for the first time glass came into daily use.

Prior to the introduction of blown glass the material had been used mainly for small brightly colored objects such as beads and ornaments of various kinds. In particular many of the precious stones were successfully imitated in glass, the copies becoming so faithful in fact that once even the Empress Salonina was egregiously cheated by a fraudulent jeweler. With the blowing of glass came what was to remain one of its commonest uses, that of a receptacle for liquids, especially wine or water, and of vessels from which these could be drunk.

The luxury of Rome caused the older forms of glass to be adopted for some interesting new purposes. The little plaques of glass inlay used by the Egyptians for wall decoration became popular, and from this sprang the use by the Romans of slabs of glass imitating porphyry and other marbles. The partial substitution of these glass slabs, which were frequently of quite large size, for the real marble veneer, led in turn to the use of glass veneering in private houses, not only for pillars in entrance halls, but commonly for the walls of bathrooms.

One class of glass from Rome and Crete forms a curious link between Egyptian mosaic inlay and the blown glass of imperial times. Roman "Millefiori Glass," or "glass of a thousand flowers" has usually been found in the form of little bowls, cut over and polished. These were made from very short sections of glass rod or cane, each of which again consisted of multi-colored cane of smaller diameter. The effects obtained resembled powdered stars, minute flower-heads, or the rich combinations of colored marbles and quartz. The advance over Egyptian practice lay not merely in a greater range of color schemes, but in the use of the hollow bowl form by the Romans instead of the restriction to flat inlay strips as in ancient Egypt.

Mirrors or glass plates were used as early as 58 B. C. for wall decoration in the theatre of Scaurus. Very rarely little circular mirrors of convex glass for personal use are recovered from Greco-Roman tombs. One of these now in the Musée Guimet at Paris is still quite brilliant, and is set in a silver frame with a ring so that it can be hung from a necklace.

Window glass is seldom met with until the 3rd century A. D., but a very limited number of glazed window-slits have been found in position in houses in both Herculaneum and Pompeii, and as these cities were destroyed in the reign of Titus, its employment must have begun as early as the or rolled, being sometimes polished afterwards. It was thus 1st century. The Roman glass for windows was either cast more nearly related to plate than to sheet glass.

Roman molded glass naturally falls into the two normal divisions of this class. There is first the type in which the glass is pressed or stamped, that is to say, the kind in which the inside as well as the outside of the object comes in contact with the mold. By this method the Fomans made their imitation jewels and, on a larger scale, reproductions of cameos, of which the commonest show heads of Medusa or Jupiter. There is then the other division of molded glass, in which the metal is blown into the mold. Of this type are many Roman flasks and other glass containers.

Blown hollow ware was in general use in Italy soon after the middle of the 1st century A. D. Dillon observes that the vast collection in the Naples museum has come chiefly from Pompeii, and must have been made between 63 A. D. and 79 A. D., because in the earlier year the town experienced an earthquake so severe that little glass can have survived it, and in the latter year was destroyed. There was a steady improvement in technique; thus from the green-tinted glass of the early days of the empire there was a change to better color and quality; in the time of Constantine, and by the reign of Nero white crystal-like glass, much freer from such imperfections as air-cavities, was being produced. A writer, Strabo, in the time of Augustus, states that in Rome the manufacture of glass had become so simple that "a succesful imitation of crystal may now be made so cheaply that a drinking glass with its stand can be sold for a copper coin."

From the blowing of glass came the power to make objects of larger size than had been possible before. Some of the cinerary urns that have been dug up are gigantic. In this connection it may be noticed that vessels for containing the ashes of the dead are not the only kind of sepulchral glass. In point of fact much of the primitive and classical glass that has come down to us has only survived because it was placed in tombs for the use of the dead in a future life. The fragile nature of glass makes its burial in stone coffins

or chambered tombs almost the only way in which any quantity of it could exist through the ages.

The Romans decorated blown glass in various ways. One of the earliest methods was by means of "trailed stringings," that is by application of a series of parallel cords or ribs to the surface of the glass. These were fused on at the time of making and were often in color, although the vessel itself was usually of clear glass. Sometimes these ribs would be coiled round the neck of a bottle, giving a firmer grip to an unsteady hand as well as being ornamental.

In a work entitled "Des coutumes et cérémonies observées par les Romains," translated from the Latin of Nieupoort by the Abbé Desfontaines, and quoted by Sauzay, details are given of the glassware used in connection with the burning of the dead. Then comes the passage, "Let us leave this sad spectacle for a much more cheerful subject—a Roman lady's toilet. There we shall find proof that, if the ancients have endowed us with a great number of wonders, they have been well avenged by transmitting to their descendants that fashion, now, alas! too common, which in spite of all the skill of the painter, absolutely deceives only the person who uses it—that of painting the skin. Yes, readers, the Roman ladies of the Decadence painted themselves, and it even appears that they were perfect mistresses of the art. We will notice a hollow colored glass ball which contained the paint, and the necessary adjunct of which is a twisted glass wand, flattened at each end, which served to spread the color on the face."

If the habits of ladies do not change, the forms of glass certainly do. Klamfoth has recently traced the evolution of Roman drinking glasses. He observes that the drinking vessels of ancient Rome form a striking contrast to those in use today. To begin with, their form was simple, being that of a bowl or bulb, without handle, flange or rim. There was no stem, or bottom on which the glass could stand, and no kind of decoration was used. In the time of Nero a handle and thumb rest were added, but the original form also persisted for centuries. The shape gradually evolved so that the bowl gave way to a vase-like glass with double handles. Still later a flat bottom was introduced, followed by the insertion of a stem between the base and the cup, and the beginnings of thread decoration. Much that we take for granted in glass has, therefore, a long history behind it.

A somewhat remarkable fact is that while the evolution of form has been constantly taking place, as we have seen in the case of drinking glasses, the chemical composition of glass has remained much the same over long periods. In the history of the industry we find that changes in composition have been rare, and introduced only at intervals far apart, advances in this direction being apparently almost fortuitous until nearly the end of last century. Even the important and fruitful work that has been done in recent years in extending the range of glasses has not always rendered obsolete the earlier standard batches. It was shown recently by Professor W. E. S. Turner, D.Sc.,* that the soda-lime glasses now in extensive use for automatic machines were not unlike those employed by the Roman glassmakers seventeen to nineteen centuries ago. Two Roman glass containers which Professor Turner had had analyzed contained between 8 and 8.5 per cent of lime or lime and magnesia and between 17 and 18 per cent of soda, with about 70.6 per cent of silica, whereas much of the colorless glass being used successfully at the present time on automatic machines contains 7.5 to 9 per cent of lime, 16.5 to 18 per cent of soda, and 72 to 74.5 per cent of silica.

The greatest triumph of the Romans in glass was in the production of their cut or sculptured pieces, which in the best examples reveal almost uncanny skill. Three or four specimens in particular are of outstanding merit, and deserve special notice. These are the Portland or Barberini Vase, the Naples Vase, the Auldjo Vase, and perhaps a scluptured cup belonging to Lord Rothschild. It may be of interest briefly to consider these splendid works in turn.

The most famous of the series, and probably the most celebrated glass antique in the world, is the Portland Vase, a two-handled cinerary urn found towards the end of the 16th century in the marble sarcophagus of Alexander Severus close to Rome. It is believed to have been placed in the tomb at the time of the death of the said Emperor Severus in A. D. 235, and to have contained his ashes. The excavations which brought it to light were superintended by Matteo Barberini, afterwards Pope Urban VIII, who, realizing its significance and almost priceless value as a unique piece of craftsmanship in glass, treasured it in the Barberini Palace. It remained there until it was bought by Sir William Hamilton in 1770, who sold it in 1786 to the then Duke of Portland for £1,029. Since 1810 it has been on loan to the British Museum, where it is shown in the "Gold Room." In 1845 a drunken madman smashed it to bits with a stick. The fragments were so skillfully put together, however, that it has not only been possible to exhibit the glass again, but tracing the lines of the breakage is almost beyond the power of the naked eye. In 1929 it was offered for sale by the present Duke of Portland, but although £29,000 was bid, this sum was refused.

The Portland Vase has a body of dark blue glass, over which is a casing of opaque white glass. Through this upper layer the craftsman sculptured his landscape and figures. It will be evident that the Romans had progressed far in their knowledge of the material when they could arrange for two glasses of different color to have what must be almost exactly the same coefficient of expansion as in this case. The vase stands ten inches high and is six inches wide. The carving is in a style reminiscent of the cameos of the Hellenistic Greeks. The beauty of the piece is much increased by the fact that where desirable the cutting has not been carried right down to the blue base, a thin film of translucent white having been left, which produces the illusion of perspective, shade and distance. The figures are most attractively grouped and are finished with the greatest delicacy. They are supposed to represent on the obverse Thetis consenting to be the bride of Peleus, in the presence of Poseidon and Eros; and on the reverse Peleus and Thetis on Mount Pelion. The vase is mounted on a base of different but inferior workmanship, on which is shown the bust of Paris.

*"The Composition of Glass Suitable for Automatic Machines," Journal of the Soc. of Glass Technology, Vol. X, 1926, p. 80.

Next in rank to the Portland is the Naples Vase, so called because it is now preserved in the Naples Museum. It was discovered in 1837 in a tomb in Pompeii, and dates, therefore, from the first century A. D. Mr. Walter Butterworth has remarked that the scene represented on the carved surface of his vase might have been taken straight from the pastoral poetry of Sicily: shepherd boys playing musical instruments, sheep and goats feeding, vines, birds, conventional putti (boys' figures), masks, etc., all delightfully carved, leaving the figures and decorations in white relief on the purplish blue ground. Gaiety and lightsomeness permeate the composition. The design is full of charm.

The Auldjo Vase, also found at Pompeii, was for long in fragments. The bulk of the pieces, after passing through various hands, have now been brought together in the British Museum; but the vase is still incomplete. The design is of ivy leaves and other foliage with the fruit of the vine.

The cup in the possession of the Rothschild family is of olive-green glass which appears of a red or purple color by transmitted light. Round it are carved five figures in almost complete relief, said to represent the "Madness of Lycurgus." The glass is believed to date from early in the 3rd century A. D.

Glass is a Lobster

By F. W. PRESTON

ONCE upon a time (it is a hundred years or more ago) the French brought out a new dictionary, wherein things were to be defined with precision. The Lobster was defined as "a little red fish that runs sideways." Cuvier, the great French naturalist, observed that this definition would be perfect except for three things: that the lobster was not a fish, that it did not run sideways, and that it was not red till boiled.

In a very friendly way, I have frequently objected to the use of the definition of glass, that "glass is an undercooled liquid."

Glass has often been thus defined, but the definition has not meant very much to those of us who were not physical chemists. It has, in fact, tended to confusion among some who cannot readily admit that a thing is gold because it glitters, or that a palpable solid is a liquid because it possesses, in common with liquids, an obscure thermodynamical relationship to crystals.

The fact that glasses possess some of the properties of the liquids does not make them liquids, when they lack very emphatically the characteristic and diagnostic property of liquid, namely, the ability to flow. To take the contrary view, that it is permissible to call them liquids, is possibly justifiable in the private lives of thermodynamical chemists, but the word is scarcely admissible in public places. It involves redefining the word "liquid."

The dictionary defines a liquid as that which flows, and glass at room temperature is much less capable of flowing than such characteristic solids as iron or steel. It does not flow, as a liquid should, under infinitesimal stresses, or even under large stresses. In fact, if the estimates of Preston[1], and of Littleton[2] are correct, or approximately so, glass formed at the dawn of creation and subjected ever since to as high a stress as it will stand, would not have flowed at all.

On this basis, the mechanical, or "engineering," or man-in-the-street's, or lexicographer's, glass is *not* a liquid. We can only so regard it by concentrating our attention on a very limited aspect of the question.

In the same way, a man on the top of Pikes Peak, who chose to disregard everything around him, and concentrated his attention entirely upon a small area in Denver seen through a powerful telescope, might say that from his point of view, America was a railroad station, and that the other properties of America were not relevant to this definition.

The physical chemist describes glass as a liquid because it is not in his eyes a gas and not a crystal. The fact that it shares with crystals as many properties as it shares with liquids is immaterial. By sufficiently restricting our viewpoint, however, and considering the behavior of the material towards X-rays, or something still less important, it ought to be possible to prove that glass "in a highly technical sense" is a gas.

Let us however, for the moment, leave the word "liquid" and think about "undercooled."

It is true that most glasses, at room temperature, are "undercooled," that is, are below their crystallizing temperature, the so-called "liquidus temperature," but there is nothing in the constitution of glasses to *demand* that they be below the liquidus.

In the ternary system Soda-Lime-Silica, one ternary eutectic at least, has a liquidus temperature of only 725° C. Dr. Morey[3] informs me that the liquidus temperature of part of the Soda-Magnesia-Silica system lies much lower. Kracek[4] in the Soda-Potash-Silica system finds one eutectic at 540° C. There is no reason to suppose that these are the lowest liquidus temperatures that will be found. One might very well expect to find lower ones in glasses of four components or more, and there is no apparent reason why the liquidus temperature should not, with some glasses, be below room temperature.

As we know the liquidus temperature of only a few glasses, the statement that glasses in general are below their crystallizing temperature is a considerable extrapolation. We are in danger of discovering glasses that are *not* "undercooled."

So we finally have glasses thus defined: "A glass is an undercooled liquid, lacking liquidity, and, as a rule, merely assumed to be undercooled."

[1] J. Am. Ceramic Soc.—pp. 374 and 377—July, 1932.
[2] Pittsburgh Meeting Am. Ceramic Soc., 1933, cf. Glass Industry, March, 1933—p. 31.
[3] Verbally.
[4] J. Phys. Chem. XXXVI (Oct. 1932)—p. 2539.

One or two recent pronouncements are of interest here. Thus, Zachariasen[5] writes, "Glasses are described as supercooled liquids or as solids. The former term is justifiable from the point of view of physical chemistry, the latter from the theory of elasticity."

Again, Morey[6] writes, "It should be emphasized that in this discussion the term "liquid" is used in a highly technical sense. As used in connection with phase equilibrium studies, a liquid is a non-crystalline phase, not a gas, which limits the range of existence with increasing temperature of a crystalline phase, and the idea of fluidity or rigidity plays no part in this definition. The argument as to the propriety of calling a glass an undercooled liquid is pointless. There can be no question that a glass is a liquid from the point of view of phase equilibrium, and the circumstance that it may at the same time possess properties which according to some other definition are characteristic of a solid is not pertinent. Glasses, then, are undercooled liquids . . . ."

It would, I think, be very much better to say, "Glasses, then, sometimes possess some of the properties of undercooled liquids."

The proof that they are undercooled must be furnished in each individual case.

We have recently had the good fortune, apparently, to demolish the concept of a "Transformation Temperature" at which molten glass passes from a true liquid to a true glass. The papers of Morey[7] and Littleton[8] to the Joint Meeting at Washington in April of this year, seem definitely to have abolished this boundary. No one will shed tears at its demise, and the abolition of any apparent boundary between the liquid state and the glassy state will of course be a further argument in favor of considering glasses as overstiffened liquids.

But what we have established is not that glass is a liquid, but that it can solidify without crystallizing. This was known before, and was the current concept before the "Transformation Temperature" was invented to plague us.

We may apparently speak as follows:

When a liquid solidifies without crystallizing, it becomes a solid glass.

A material which normally thus solidifies, may when melted, be called a molten glass.

The material may be regarded as "glass" whether it is melted (liquid) or solid, just as iron may be molten or solid.

There is no specific temperature dividing liquid glass from solid glass. The transition is gradual.

The above statements will permit the continuance of the language of industrial glass men without seriously curtailing the rights of physical chemists. In their investigations they will continue to think of "glass" as being essentially a liquid: (this is mainly because they cannot continue their investigations as physical chemists when the glass is "solid," so they will always be working with it in a fairly liquid condition): in the privacy of their chambers they may speak of it as the "liquid phase": but in public they should not stress their word "liquid," lest they cause little ones to stumble.

Zachariasen[9] has given what appears to be a valuable interpretation of the probable structure of solid glass. I may paraphrase it thus, "Glass is a solid with a higgledy-piggledy lattice." It meets the ordinary requirements of physics and industry very well, and I think it also meets the requirements of the physical chemists.

It is the most solid (least fluid) form of solid, because it is least capable of flow. A viscosity may be assigned to it on theoretical grounds, as has been done by Littleton[10] and Preston[11], and this viscosity is finite, not infinite. But as shown by the latter writer, the viscosity is so high that, in a universe of granular structure (i. e., of molecular structure), in a universe also which is probably limited in extent and in duration, it has no physical meaning. Such a viscosity can never be *observed* in this universe, either by mortal man, or by the Gods on Olympus. The whole of space and time and all the forces of the universe could not produce one molecule's distance of flowage; could not, at room temperature, have displaced one molecule, viscously, from its attachments

A material which can stand the test of all eternity without slipping, is preferably regarded as a solid, possibly an impertinent solid.

If I build a frame house, I set my two-by-fours in a recognizable array, in vertical and horizontal positions, and with uniform spacings. I have to nail them together to keep them so, or the house will fall down. Such a house is a crystal.

If I hire a lot of pixies, trolls, or goblins, to run around on my house site, each with a two-by-four, carried at any old angle, without any system to their motion, each hobgoblin bumping into his fellows and changing his course continually: that is a liquid.

If I command every goblin to stop motionless, and then nail all the two-by-fours together at their nearest points or wherever they touch, that is a glass.

The motion makes the liquid: the nails make the solid: the orderliness makes the crystal: the higgledy-piggledyness makes the glass.

[5]W. H. Zachariasen—J. Am. Chem. Soc.—Vol. 54—p. 3841 (Oct. 1932).
[6]G. W. Morey. Joint Meeting of Am. Chem. Soc., and Am. Ceramic Soc. (Mar. 1933).
[7]Loc. cit.
[8]Preprinted abstract. cf. National Glass Budget—Apr. 1, 1933—p. 8.
[9]Loc. cit.
[10]Loc. cit.
[11]Loc. cit.

Plate Glass Production in April

The total production of polished plate glass by the member companies of the Association for the month of April, 1933, compiled by Secretary P. A. Hughes of the Plate Glass Manufacturers of America, was 4,679,776 sq. ft., as compared to 4,881,322 sq. ft. produced by the same Companies in the preceding month, March, 1933, and 5,025,008 sq. ft. produced by the Association members in the corresponding month last year, April, 1932.

April Construction Contracts

The April contract volume for construction of all types, according to the F. W. Dodge reports, amounted to $56,573,000; this contrasts with $59,958,500 for March and $121,704,800 for April of last year. For the first four months of 1933 contracts totaled $252,599,800 as against $407,783,500 for the corresponding period of 1932.

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Do We Need a National Trade Association?

THE National Industrial Recovery bill has already become a law which puts into President Roosevelt's hands practically unrestricted power of control over the country's industries, most of which authority apparently will be passed on to General Hugh S. Johnson, who on May 29 was named authoritively at Washington as co-ordinator of the industrial control of industries. The primary purpose of the bill is to establish and maintain stability in industries by opening up opportunities for employment, maintaining or increasing wages, standardizing hours of work, preventing over-production, eliminating price-cutting, and other evils, and enforcing fair prices.

These results are expected to be brought about in each industry through free co-operative or compulsory co-operation by the industry's trade associations. Nothing has been made public, however, as to the means by which the activities of these associations will be co-ordinated and made effective.

So far as the glass industry, for instance, is affected, there are about a dozen trade associations devoted mainly to the manufacture and marketing of glass in many different forms and involving different problems. Most of these confine their activities to one or two of the several distinct branches of the industry but on various matters of importance to the entire trade there is little or no co-operation among the associations and no common ground exists, such as a glass trade association covering all branches of the industry, wherein the members can discuss their problems with their fellow members.

In this connection, the president of a prominent manufacturing plant sums up the present situation regarding control as follows: "If our manufacturers expect to retain some control of our branch of the industry we will have to have an active and workable trade association to govern the activities of its members, otherwise it now appears that the Government will do this for us."

Most of the glass industry's trade associations are extremely useful adjuncts to the trade but are limited in their possibilities for effective action on large questions, because not united. This paper during the past years has repeatedly emphasized in print and various other ways the desirability of organizing glass trade associations into a national unit in order that the industry, acting as a unit can develop its full power when needed in emergencies such as that which confronts the trade at this time. Such suggestions, however, have usually met with a luke-warm reception.

But it is not only for emergencies that such an organization could be of benefit to the trade. There are other ways in which it could be used effectively. For instance, the trade associations of the various branches of the industry being unorganized are not able to handle such matters as tariff revision as effectively as they could with the influence that could be wielded by a national glass trade association.

Considerable criticism has been directed to apparent inconsistencies in the Industrial Recovery bill. Some of

these have been commented on by President Lund of the National Association of Manufacturers, which is heartily supporting the objectives of the bill, who declares that certain provisions in it are unworkable and conflicting and that furthermore provision must be made giving the President authority to regulate imports in order to counteract rising domestic costs. The National Association also considers the license section highly objectionable and unnecessary and unconstitutional. It also considers that the labor provisions of Section 7 should be eliminated or at least revised in such form as to operate equally on both employes and employers. The Association also maintains that the measure cannot be administered satisfactorily by a single administrator and that provision should be made either by legislation or executive order for setting up an Advisory Committee to interpret the practical needs of the industry.

President Roosevelt has recently been conferring to the industry control measure as a partnership agreement with the Government to solv industry's problems. This appears to be a further assurance that no unreasonable or unjustified interference with industry is likely to take place.

Tariff Commission Report on Blown Glass Tableware Costs

*Abstracts from Report No. 60, Second Series**

(*Continued from May issue*)

In general terms, it may be said that the imports of blown-glass tableware with few exceptions are confined to relatively small orders as to quantity, and that a large part of the imports is represented by novelty ware of a kind not ordinarily produced in the United States. There is nothing imported similar to the bulk of the pressed stems produced in this country (the imported pressed stems are confined almost entirely to a pressed stub stem with a pressed foot). No plate etchings are imported similar to the designs so popular in the United States (imported plate etchings are confined to monogram ware). In recent years it is believed that there have been little, if any, importations of articles competitive in price with the domestic tank furnace products.

Domestic Consumption

Hand- and machine-blown or partly-blown glass tableware is sold throughout the United States. In view of the fact that the domestic production, imports, and exports of blown-glass tableware are not clearly indicated by available statistics, the domestic consumption of this commodity can not be stated with any degree of accuracy.

Prices in the United States and in Czechoslovakia

Domestic hand-blown glass tableware is sold in quantities varying from a comparatively few articles to carload lots. Selling prices for the domestic and foreign wares vary according to quality and color of glass, designs, whether undecorated or decorated, quantity, and in accordance with varying competitive conditions. Information obtained during the investigation indicates that individual orders placed with the foreign factories by importers of Czechoslovakian glass tableware are, on the whole, smaller in quantity than is usual in the case of purchases by the American trade from domestic plants.

A comparison of costs of production, f.o.b. plant, including commission and selling expense, with the net selling price packed, indicates that out of a total of 419 selected domestic articles, 164 articles, or 39 per cent, were sold at a loss. Available data indicate that out of a total of 131 selected Czechoslovakian articles, only 5 articles, or 4 per cent, were sold at a loss.

Elements of Cost—United States and Czechoslovakia

The following description covers the general procedure by which cost data were obtained in the United States. In Czechoslovakia the cost records were not kept in the same detail as in the United States; however, the departmentalized costs include substantially the same items and were calculated on approximately the same basis for both domestic and foreign costs.

Departmentalized costs were obtained at each plant. By the methods used there were allocated to the service and production departments all expenditures for heat, light and power, depreciation, insurance, taxes, repairs and maintenance, indirect labor, factory supplies, and general factory expenses. The total charges to the service departments were then charged proportionately to the several production departments.

1. *Batch materials.*—The total purchases of batch materials for the year were analyzed and summarized as to quantities and values (delivered cost at plant) in order to arrive at a weighted average purchase cost per pound for each batch material. The fusing losses were computed by deducting the average weight of the pullable glass in a given batch from the total gross weight exclusive of cullet (cullet is the broken glass used for remelting). The cost per pound for each kind and class of glass was derived by dividing the net weight of the batch into the total batch cost.

2. *Mixing and melting.*—The cost of these combined operations includes: The cost of labor in the mixing of the batches, and all operating costs in connection with the same; the cost of gas for the furnaces, either pot or tank, as well as the cost of pots where used; furnace repairs, maintenance, and depreciation; supervision; supplies, and a proportion of plant overhead (the latter covers depreciation, fire and compensation insurance, building repairs, general supplies, administration, and taxes).

3. *Blow shop wages.*—This item includes all skilled and unskilled labor involved from the time the gather of molten metal is made until the article is placed in the annealing lehr.

4. *Shop and lehr expense.*—Shop and lehr expense includes gas or other fuel for lehrs and shop (exclusive of gas for melting furnaces), electric power, and light; supplies; labor (except glass blowers, boys, and others who work with the glass blowers, such as gatherers, foot setters, etc.), fixed

inconsistencies in the Industrial Recovery bill. Some of

* Copies of this 60-page report containing numerous tables relating to the production, consumption, costs of blownware and other data may be obtained at 10 cents a copy from the Superintendent of Documents, Washington, D. C.

charges, proportional factory overhead, and generad administrative expense. It also includes labor at the lehrs, except the boys who carry the glassware (after it is blown) to the lehrs for annealing.

5. *Finishing labor.*—This item includes the labor cost on all finishing operations, such as cracking off, grinding, wiping, glazing, final selection, and wrapping.

6. *Finishing expense.*—This item includes cost of gas for the cracking-off and glazing machines; power for the cracking-off grinding, and glazing machines; heat and light, depreciation of finishing equipment, and proportional overhead chargeable to the finishing department.

7. *Packing labor, material, and expense.*—This item includes all labor involved in packing, the cost of containers (domestic, usually barrels, although some paper cartons are used; foreign, cases), the cost of packing materials, such as paper, hay, etc., and proportional overhead, and administrative costs and expenses.

8. *Warehouse and shipping.*—This includes labor in the department and proportional general overhead and administrative expense.

9. *Interest on investment.*—Interest at 6 per cent was computed on the basis of the depreciated value of fixed assets (land, buildings, machinery, and equipment), and on inventories for finished goods and supplies.

Commission and selling expense have not been used in the cost comparisons.

Treatment of Costs—United States and Czechoslovakia

With few exceptions, domestic and Czechoslovakian plants producing hand-blown glass tableware do not maintain complete cost records for specific articles. Many of the plants, however, maintain records that are adequate to determine a general specific cost without maintaining a relatively large cost department to prepare detailed production costs. The determination of production costs for specific blown-glass tableware articles presents a very difficult problem. In addition to the production of blown-glass tableware many of the domestic plants produce other types of glass, such as pressed glassware, machine-processed glass, and illuminating or industrial glassware. Generally, the variety of specific articles of blown-glass tableware produced by each plant is very extensive, and the production of the individual pieces is usually intermittent.

Hand-blown glass tableware is frequently produced from glass melted in the same pot or furnace from which molten glass is drawn to produce pressed glass, and hand-blown glass tableware is even produced from the same tank furnaces that supply glass for machine-blown or machine-press-blown glass tableware. In the production of the glass there are certain indefinite factors that affect specific costs. For example, a pot (melting crucible) may break shortly after it is placed in the furnace, resulting in a loss of the batch (raw materials), together with a total loss of the pot. After the articles have been blown there is always a varying appreciable breakage in the course of finishing operations. These many uncertain elements, together with varying production factors, made the proper proration of costs to specific articles a very difficult problem. Under Elements of Cost a description has been given of the scope of the various cost items, such as "batch materials" and "mixing and melting." While raw material costs were comparatively easy to calculate, other cost items required detailed analysis in order to insure proper allocation. Extreme care was taken to make a thorough study and to make full use of all pertinent data. In some domestic plants the basic data were available in even greater detail than in other plants, but all of the domestic plants had more detailed records than the Czechoslovakian plants. For example, in most of the domestic plants daily records of production were kept for each article. The compilation and summarization of these data by the commission required a considerable amount of time. In Czechoslovakian plants the production records are only retained for pay-roll purposes and are then discarded, and accordingly production data for specific articles could not be obtained. The Czechoslovakian plants for which cost data were obtained generally produced only hand-blown glass tableware, and accordingly the difficult problems arising in allocation of costs presented in the computation of domestic costs were not presented in computations of costs for the foreign product.

Wages and Relative Productivity in the United States and Czechoslovakia

Wage rates in the hand-blown glass tableware industry in both the United States and Czechoslovakia are on practically the same basis. In both countries the skilled labor, such as gatherers, blowers, stem and foot makers, etc., are paid on what is essentially a piece rate. Most of these workers are members of unions. The unskilled labor, such as carry-in boys, selectors, etc., is paid on an hourly or weekly basis. When a new article is to be manufactured in the United States, the quantity (known as "move") of this article that is to be produced in a "turn" (usually 4¼ hours) for the purpose of establishing a piece wage rate for that article is a matter of agreement between the manufacturers and the workmen. Cooperation through the union and the manufacturers' association usually results in similar articles at other union plants having the same "move" established. The amount to be paid to the blower and some of the other skilled workers is designated; the wage of the gatherer usually is equivalent to 75 per cent of the blower's wage. In the United States, the blower is usually the highest paid and is the "head" of each group (shop). Basically it is planned by these wage agreements that the wages paid the individual workers for specific occupations will average approximately the same over an extended period, although a highly skilled group will generally produce more acceptable or "good" ware than a less skilled group. There are a number of rules and agreements covering the working arrangements between the manufacturers and employees. These agreements are made on a yearly basis, but for the most part few changes occur from one year to another except with respect to the establishment of "moves" for new articles. If the workers produce good ware in excess of the "move" they are paid for the excess on the basis of the established stipulated rate for the "move." If the glass becomes cordy or "bad," or if for other reasons for which the manufacturers are responsible, production at the furnaces is suspended, the workers receive full pay per turn during such suspension. Substantially the same practice is followed in Czechoslovakia with respect to agreements as to the number of men and output per shop, etc. In Czechoslovakia the

"master"—who generally makes the stem or stem and foot—is the head of each group and receives the highest pay. Under usual conditions approximately 48 hours constitute a week's work in both the United States and Czechoslovakia. It is interesting to note that plants in the United States operating on a 1-shift basis start work at approximately 7 a. m. the year round, whereas during the summer months most of the skilled workers in the Czechoslovakian plants start work about 4 a. m., and with definite intervals for meals their work is finished shortly after noon. It was stated that this arrangement was made to permit the workers to spend the afternoons in their garden plots. In the winter months, a number of these plants do not begin operations until 7 a. m. The union rule in the United States provides that 46¾ hours shall constitute a week's work; some of the domestic plants, however, are operated on a nonunion basis.

In December, 1918, an 8-hour working day and a 48-hour working week were established by statute for Czechoslovakian industries. The law enacted in 1925 provides that Czechoslovakian workers shall be given annually a vacation with pay for a period of from six to eight days. Czechoslovakian workers are also allowed approximately seven holidays a year with pay, and a sickness insurance fund provides compensation in case of illness. If the illness continues for a period of more than three weeks, the worker receives 10 per cent of his wages from the employer, and if he is still ill at the end of five weeks, he receives 20 per cent of his wages in addition to the regular benefits from the sickness insurance fund.

Four of the Czechoslovakian manufacturers of hand-blown glass tableware from whom cost data were obtained supply their workmen rent-free houses or rooms and garden plots. One other manufacturer gave the workers a monthly allowance in lieu of rent-free housing, and the other four manufacturers gave similar allowances to workers who owned their own homes.

The cost of social insurance, including sickness, old age, and invalidity insurance, is divided equally between employer and employee. All dues for accident insurance are paid by the employer. In the United States none of the workers in the blown-glass tableware plants receives allowances in the form of rent-free housing, or of the character provided by statute for workers in Czechoslovakia, with the possible exception of indemnity in the case of accidents in the performance of their duties.

Excluding the amount of the wages shown in the table for the press-trim operation in the United States, which is not used in Czechoslovakia, the average amount of the direct wages paid specific workers—based upon figures for an average week—in domestic plants was approximately four and one-half times the direct and indirect wages paid in Czechoslovakia to workers performing comparable operations.

The Owens-Illinois Glass Co.

Through secretary of the Owens-Illinois Glass Co., John W. McNering, there was announced in May the retirement of its entire outstanding issues of $3,774,000 of 5% debentures and $8,000,000 of Preferred Stock, as well as the 6 % First Mortgage Bonds of Root Glass Company assumed by this Company. This is being accomplished through the issuance of 200,000 shares of the Company's Common Stock and by the use of part of the surplus funds in the Company's treasury.

The company on May 4, through President Wm. E. Levis, announced that contracts had been entered into for the purchase of the entire assets and business of Hemingray Glass Company of Muncie, Indiana, manufacturers of glass insulators, and of substantially all the assets of The O'Neill Machine Company of Toledo, Ohio, manufacturers of glass bottle blowing machines of the vacuum type.

This business will become a part of the Industrial Materials Division of Owens-Illinois Glass Company which has recently developed a number of new glass products, among them glass wool for building insulation and for air filtering installations. A glass building, now under construction at the Century of Progress Exposition at Chicago, will introduce glass block as a structural and decorative material to the public.

The O'Neill Machine Company has been engaged in the experimental development of an automatic bottle blowing machine using the vacuum or suction process of drawing glass into the molds. The acquisition settles patent litigation between Owens-Illinois and O'Neill, and is expected to strengthen the present patent position of Owens-Illinois Glass Company, and be the forerunner of further developments in automatic bottle blowing machines.

(*To be continued*)

One Hundred Years of Progress Illustrated

The official opening of the One Hundred Years of Progress Exhibition in Chicago took place on May 27. An interesting feature is that light, which took 40 years to arrive at Chicago after leaving the star Acturus, 240 trillion miles distant and 150 times as bright as the sun, entered the four telescopes of Yerkes Observatory at Geneva, Wis.; Allegheny Observatory, Pittsburgh, Pa.; the University of Illinois, Urbana, Ill., and Harvard College Observatory, Cambridge.

The last current to arrive came from the Yerkes Observatory and threw the master switch, whereupon a powerful searchlight on the Tower of the Hall of Science began to sweep the fairgrounds, and to light up the many buildings of the Exposition.

One of the most conspicuous buildings at the fair is a unique structure, built of colored glass blocks by the Owens-Illinois Glass Company of Toledo, Ohio.

This glass-block building, the first full-sized structure of its kind ever built, is the result of years of scientific study and planning, and represents a triumphant presentation to the world of a new type of building material, practical, colorful, versatile and economical, ready for the immediate use of industry and commerce, and already attracting the serious attention of architects and builders all over the world.

Numerous other uses for glass are being demonstrated in the Exposition.

Current Prices of Glass-Making Materials

May 19, 1933

Quotations furnished by various producers, manufacturers and dealers

Acid		Carlots	Less Carlots
Citric (dom.)	lb.	...	.29
Hydrochloric (HCl) 20° tanks	Per 100 lb.	...	1.10
Hydrofluoric (HF) 60% (lead carboy)	lb.	...	.13½
52% and 48%	lb.	.10	.10–.11½
Nitric (HNO_3) 38° carboy ext	Per 100 lb.	5.50	...
Sulphuric (H_2SO_4) 66° tank cars	ton	15.50	...
Tartaric	lb.	... Po. or Gr. / Cry.	.20 / .30½
Alcohol, denatured	gal.	...	...
Aluminum hydrate ($Al(OH)_3$)	lb.	.04–.04½	.05½–.06
Aluminum oxide (Al_2O_3)	lb.	.07	.09
Ammonium bifluoride (NH_4) FHF	lb.	...	.14¾
Ammonia water (NH_4OH) 26° drums	lb.	...	.02¾
Antimony, metallic (Sb)	lb.	.02½	.02¾
Antimony oxide (Sb_2O_4)	lb.	0.7	.07½
Antimony sulphide (Sb_2S_3)	lb.	...	.08½
Arsenic trioxide (As_2O_3) (dense white) 99%	lb.	.04	.04½
Barium carbonate ($BaCO_3$), Crude, (Witherite) 90%, 99% through 200 mesh	ton	56.50	...
90% through 100 mesh	ton	44.00	...
Barium hydrate ($Ba(OH)_2$)	lb.	...	.05¼
Barium mixture, glassmaker's, f. o. b. St. Louis	ton	25.00	...
Barium nitrate ($Ba(NO_3)_2$)	lb.	...	.07¼
Barium selenite ($BaSeO_3$)	lb.	...	...
Barium sulphate, in bags	ton	19.00	24.00
Barium sulphate, glassmaker's, carlots, bulk f.o.b. shipping point	ton	15.00–16.00	18.00
Bone ash, carlots	lb.	.06	.06
Borax ($Na_2B_4O_7 10H_2O$)	lb.	...	...
Granulated	In bags, lb.	.02	.02¼–.02½
Powdered	In bags, lb.	.02¼	.02½–.02¾
Boric acid (H_2BO_3)	In bags, lb.	.04¼	.04½–.04¾
Cadmium sulphide (CdS)—			
Red	lb.	...	.60–.75
Orange	lb.	...	.55–.65
Yellow	lb.	...	1.30–1.50
Chromium oxide (Cr_2O_3)	lb.	...	.18
Cobalt oxide (Co_2O_3)			
In bbls	lb.	...	1.15
In 10 lb. tins	lb.	...	1.25
Copper oxide			
Red (Cu_2O)	lb.	...	.25
Black (CuO)	lb.	...	.17–.19
Black prepared	lb.	...	.22
Cryolite ($Na_3Al\ F_6$) Natural Greenland (Kryolith)	lb.	.08½	.09
Synthetic (Artificial)	lb.	...	.08
Epsom salts ($MgSO_4$) (imported) technical	Per 100 lb.	...	1.50–1.75
Feldspar—			
40 mesh	ton	9.50–11.00	...
20 mesh	ton	9.50–11.00	...
Granular	ton	9.50–11.00	...
Semi-granular	ton	9.50–11.50	...
L. C. L., (Min. 2 tons) $2.00 per ton additional plus charge for bags			
Fluorspar (CaF_2) domestic, ground, 96-98% (max SiO_2, 2½%)			
Bulk, carloads, f.o.b. mines	ton	30.00	...
In bags or barrels	ton	34.00	39.00
Imported	ton	27.00	29.00
Formaldehyde	lb.	...	.07
Graphite (C)	lb.	...	.04–.07
Iron oxide—			
Red (Fe_2O_3)	lb.	...	.0425
Black (FeO)	lb.	.04½	...
Kaolin (f.o.b. mine)	ton	8.00–9.00	...
English, lump, f.o.b. New York	ton	14.50–25.00	24.50–30.00

Kryolith (see Cryolite)		Carlots	Less Carlots
Lead chromate ($PbCrO_4$)	lb.	...	.30
Lead oxide (Pb_3O_4) (red lead)	lb.	.0625	.0725
Litharge (PbO)	lb.	.0515	.0625
Lime—			
Hydrated ($Ca(OH)_2$) (in paper sacks)	ton	9.00	...
Burnt (CaO) ground, in bulk	ton	6.50	...
Burnt, ground, in paper sacks	ton	8.50	...
Burnt, ground, in 280 lb. bbls	Per bbl.	2.15	...
Limestone ($CaCO_3$)		1.50–2.50	...
Magnesia (MgO)—			
Calcined, heavy (in bbls.)	lb.	.06	.07
light (in bbls.)	lb.	...	.23
extra light (in bbls.)	lb.	...	.37
Magnesium carbonate ($MgCO_3$)	lb.	.06	.10
Manganese 85% (MnO_2)	lb.	57.50	60.00
Nickel oxide (Ni_2O_3), black— for nickel content	lb.	...	.35
Nickel monoxide (NiO), green— for nickel content	lb.	...	.35
Plaster of Paris, bags	ton	31.00	23.00–29.00
Potassium bichromate ($K_2Cr_2O_7$)—			
Crystals	lb.	.07½	.08
Ground	lb.	.08	.08½
Potassium carbonate—94-96%	lb.	.0555	.0555
Calcined (K_2CO_3) 96-98%	lb.	...	.06¾
Hydrated 80-85%	lb.	...	.05¾
Potassium chromate (K_2CrO_4)	lb.	...	.25
Potassium hydrate (KOH) (caustic potash)	lb.	.07½	.08
Potassium nitrate (KNO_3) (gran.)	lb.	...	.06–.06¼
Potassium permanganate ($KMnO_4$)	lb.	.16	.16½
Powdered blue	lb.	...	.16½–.17
Rochelle salts, bbls	lb.	...	.11½
Rouge	lb.	...	...
Rutile (TiO_2) powdered, 95%	lb.	.15–.20	.20–.25
Salt cake, glassmakers (Na_2SO_4)	ton	18.00	...
Selenium (Se)	lb.	...	1.70
Silver nitrate (AgNO)	(100 oz) per oz.	...	.20¼
Soda ash (Na_2CO_3) dense, 58%—			
Bulk, on contract	Flat per 100 lb.	1.05	...
In barrels	Per 100 lb.	1.38	1.90–2.13
In bags	Per 100 lb.	1.17½	1.72½–1.92½
Spot orders	.025 per 100 lbs. higher	...	...
Sodium bichromate ($Na_2Cr_2O_7$)	lb.	.04½	.05
Sodium hydrate (NaOH) (caustic soda) Solid	Per 100 lb.	2.50	...
Sodium nitrate ($NaNO_3$)—			
Refined (gran.) in bbls	lb.	...	3.62
95 per cent	Per 100 lb.	1.195–1.295	1.145–1.345
Sodium selenite (Na_2SeO_3)	lb.	...	2.00
Sodium fluosilicate (Na_2SiF_6)	lb.	.04½	.05–.06
Sodium uranate (Na_2UO_4) Yellow or Orange	lb.	...	1.40–1.45
Sulphur (S)—			
Flowers, in bbls	Per 100 lb.	3.45	3.70–4.05
Flowers, in bags	Per 100 lb.	3.10	3.35–3.65
Flour, heavy, in bbls	Per 100 lb.	2.85	3.20–3.45
Tin chloride ($SnCl_2$) (crystals)	lb.	.27½	.28
Tin oxide (SnO_2) in bbls	lb.	.28	.29½
Uranium oxide (UO_2) (black, 96% U_3O_8) 100 lb. lots. Black	lb.	...	2.75
Yellow orange	lb.	...	1.40
Zinc oxide (ZnO)	lb.	.08½	.12
American process, Bags	lb.	.05¾	.06
Zircon			
Granular (Milled .005-.02c higher)		.07	.07½–.08
Crude, Gran. (Milled .005-.02c higher)		.03½	.04–.05

New Construction

For residential building April contracts amounted to $19,143,600 as compared with $16,021,000 for March and $28,894,700 for April of last year. Although the contract total for residential building was only about two-thirds as large as that of a year ago, singularly this class of building made the best showing as against April, 1932.

A New Indicating Pyrometer of Thermoelectric Type is anounced by the Mishawaka Industrial Instrument Manufacturing Laboratory, 936 Washington Ave., Mishawaka, Ind. These pyrometers are equipped with automatic cold junction compensation. They are encased in substantial cast aluminum cases. The instrument is 5½ inches in height, 4⅝ inches in width and 2½ inches in depth. They also furnish these for panel or wall mountings or equipped for portable use for multiple point installations. The weight of the portable type is three pounds. Standard instrument ranges are from 600 to 3000 degrees F.

New Publications

The Law of Patents for Chemists, by Joseph Rossman, Ph.D., Patent Examiner, U. S. Patent Office, Member of the Bar of the U. S. Court of Customs and Patent Appeals and the U. S. Supreme Court, Editor of the Journal of the Patent Office Society. The Inventors Publishing Company, Washington, D. C.

This work aims to give a rather comprehensive treatment of the technical subject of patent law in language which can be comprehended by chemists without legal training.

It tells why the chemist should know patent law and what patents are worth to chemists. It explains patent law principles, the steps necessary to take in obtaining a patent, discusses the patent claims, interferences, how to make corrections, corrections in patent applications, rights of the patentee, employer-employee relations in regard to patents, legal interpretations, and useful miscellaneous.

It includes an 18-page glossary defining words and phrases most commonly used in patent law, and Appendix A illustration of Official Class 23 (Chemistry); Appendix B, an illustrative chemical patent application as completely prosecuted at the United States Patent Office; Appendix C, Patent Office Statistics, information on parallel published reports, and a select list of books dealing with patent law and cases.

The Columbia Alkali Corporation, Empire State Building, New York, are offering a 30-page publication devoted to Columbia soda ash in the glass industry. Some of the subjects discussed briefly relate to the handling of dense soda ash and other bulk materials, such as lime and glass sand, batch mixing, melting apparatus, materials used in glassmaking, general chemistry of glassmaking, characteristics of manufactured glass, typical glass batches, and tables relating to some of the properties of glassmaking. Several pages are also devoted to "Segregation of Soda Ash in Glass Batches," a subject covered in a lengthy article by Dr. G. Lynn of the company's research laboratory at Barberton, O., in the January, 1932 issue of The GLASS INDUSTRY.

A novelty in connection with the new publication is the use of a sheet of cellophane bound over the front and back covers for their protection.

The Visual Fatigue of Motion Pictures. Amusement Age Publishing Company. New York, a world-wide summary and survey of 48 pages.

Edward Orton, Jr., A Memorial. A 70-page memorial volume devoted to the life and activities of the late Edward Orton, Jr.

The 1933 Standards Year Book compiled by the Bureau of Standards (Misc. publication No. 139), Lyman J. Briggs, acting director, is now available and for sale by the Superintendent of Documents, Washington, D. C., at $1.00 per copy, bound in cloth. During the year the Bureau produced 32 pots of optical glass embracing five different kinds; from a part of these melts 36,787 pounds were made for the Navy Department. It has now been demonstrated that the time required for melting borosilicate crown glass can be reduced about 45% or from 24 to 13 hours. Data is also included on composition for physical properties of glass.

The Harshaw Chemical Company's Pittsburgh, Pa., office is now located in the Pennsylvania Railroad Office Building, 7th and Carson Streets, Pittsburgh. Telephone, Hemlock 8725-8726.

The Bristol Company, Waterbury, Conn., makers of indicating, recording and controlling instruments, announces that its New York office is now located at 220 East 42nd Street. C. W. Williamson, district manager, continues in charge, assisted by a staff of six application and service engineers.

THE GLASS INDUSTRY CLASSIFIED BUYERS' GUIDE

FOR FURTHER INFORMATION, SEE ALPHABETICAL DIRECTORY OF ADVERTISERS AND CONSULT ADVERTISEMENTS

ALUMINUM HYDRATE
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.

ALUMINUM OXIDE
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.

ALUMINUM SULPHATE
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.

ANTIMONY OXIDE
Drakenfeld, B. F., & Co., Inc., New York.

ARSENIC
Drakenfeld, B. F., & Co., Inc., New York.

AUTOMATIC BOTTLE MACHINERY (See Glass Working Machinery)

AUTOMATIC CONVEYORS AND LEHR LOADERS
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Hartford-Empire Co., Hartford, Conn.

AUTOMATIC GLASS WORKING MACHINERY (See Glass Working Machinery)

AUTOMATIC TEMPERATURE CONTROL
Wilson-Maeulen Pyrometer Division, The Foxboro Co., Foxboro, Mass.

BATCH CARTS
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

BATCH HANDLING AND MIXING SYSTEMS
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

BLOWERS AND EXHAUSTERS
The Kirk & Blum Mfg. Co., Cincinnati, O.

BLOWER SYSTEMS
The Kirk & Blum Mfg. Co., Cincinnati, O.

BOND CLAY
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Laclede-Christy Clay Products Co., St. Louis, Mo.
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

BORAX
American Potash & Chemical Corp., New York.
Pacific Coast Borax Co., New York.

BORIC ACID
American Potash & Chemical Corp., New York.
Pacific Coast Borax Co., New York.

BOTTLE-MAKING MACHINERY (See Glass Working Machinery)

BRICK, INSULATING
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

CADMIUM SULPHIDES
Drakenfeld, B. F., & Co., Inc., New York.

CASTINGS, GLASSHOUSE
Dixon, H. L., Co., Pittsburgh, Pa.

CEMENT, HIGH TEMPERATURE
Laclede-Christy Clay Products Co., St. Louis, Mo.

CHEMICALS, COLORS, MINERALS, ETC., GLASSMAKERS
American Potash & Chemical Co., New York.
Drakenfeld, B. F., & Co., Inc., New York.
Pacific Coast Borax Co., New York.
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.
Sharp-Schurtz Company, Lancaster, O.
Solvay Sales Corporation, Syracuse, N. Y.

CHEMISTS, CONSULTING
Bailey & Sharp Co., Inc., Hamburg, N. Y.
Preston, F. W., Natl. Bank Bldg., Butler, Pa.
Sharp-Schurtz Company, Lancaster, O.
Solvay Process Co., Syracuse, N. Y.

CHIMNEYS, FACTORY
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

CHROME OXIDE
Drakenfeld, B. F., & Co., Inc., New York.

CLAY For Glassmakers
(See also Bond Clay, Fire and Furnace Clay)
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

CLAY POTS
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

COAL HANDLING AND STORAGE SYSTEMS
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

COBALT OXIDE
Drakenfeld, B. F., & Co., Inc., New York.

CONSULTANTS, GLASS CHEMISTS
Bailey & Sharp Co., Hamburg, N. Y.
Preston, F. W., Butler, Pa.
Sharp Schurtz Co., Lancaster, O.

CONTRACTORS
Furnace Construction and Repairs
Amsler-Morton, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Toledo Engineering Co., Inc., Toledo, O.

COOLING SYSTEMS
The Kirk & Blum Mfg. Co., Cincinnati, O.

COPPER OXIDE, BLACK
Drakenfeld, B. F., & Co., Inc., New York.

CRUSHERS & PULVERIZERS
(Cullet, Coal, etc.)
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CRYOLITE
Natural Greenland
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.

DAMPER, SAND
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

DECOLORIZERS
Drakenfeld, B. F., & Co., Inc., New York.
Sharp-Schurtz Company, Lancaster, O.

DECORATING MATERIALS AND COLORS
Drakenfeld, B. F., & Co., New York.

ELBOWS AND FITTINGS, SHEET METAL
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Chimney and Power Plant
Amsler-Morton Company, The, Pittsburgh, Pa
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Fuel and Furnace
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Bailey & Sharp Co., Hamburg, N. Y.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Hartford-Empire Co., Hartford, Conn.
Sharp-Schurtz Company, Lancaster, O.
Toledo Engineering Co., Inc., Toledo, O.
Glass Factory
Amsler-Morton Company, The, Pittsburgh, Pa
Bailey & Sharp Co., Hamburg, N. Y.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Sharp-Schurtz Company, Lancaster, O.
Toledo Engineering Co., Inc., Toledo, O.
Mechanical
Bailey & Sharp Co., Hamburg, N. Y.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Plate Glass Factory
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Producer Gas
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Wellman Engineering Co., Cleveland, O.

FANS, EXHAUST.
The Kirk & Blum Mfg. Co., Cincinnati, O.

FEEDERS, AUTOMATIC GLASS (See Glass Feeders)

FELDSPAR
Sharp-Schurtz Co., Lancaster, O.

FIRE BRICK (See also Refractories)
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Laclede-Christy Clay Products Co., St. Louis, Mo.

FIRE AND FURNACE CLAY
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Laclede-Christy Clay Products Co., St. Louis, Mo.
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

FLOATING AGITATORS
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L. Co., Box 140, Pittsburgh, Pa.

FOUNDERS, GLASSHOUSE CASTINGS
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

FURNACE ENGINEERS (See Engineering Service)

FURNACE INSULATION (See Insulating Brick)

FURNACE REPAIR MATERIALS
Amsler-Morton Company, The, Pittsburgh, Pa.
Corhart Refractories Co., Louisville, Ky.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Laclede-Christy Clay Products Co., St. Louis, Mo.
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

FURNACES
Annealing (See Lehrs)
Tank and Pot
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Recuperative
Amsler-Morton Company, The, Pittsburgh, Pa.
Toledo Engineering Co., Inc., Toledo, O.

GAS BURNERS
Amsler-Morton Co., Pittsburgh, Pa.
Bailey & Sharp Co., Hamburg, N. Y.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Sharp-Schurtz Co., Lancaster, O.
Toledo Engineering Co., Inc., Toledo, O.

GAS MAINS, STEEL
Amsler-Morton Co., Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

GAS PRODUCERS (See Producer Gas Plants)

GLASS CONSULTANTS
Bailey & Sharp Co., Hamburg, N. Y.
Sharp-Schurtz Co., Lancaster, O.

GLASS FEEDERS, AUTOMATIC
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Hartford-Empire Co., Hartford, Conn.
Miller, Wm. J., Inc., Swissvale, Pa.

GLASSHOUSE CASTINGS (See Castings)

GLASSHOUSE MACHINERY AND EQUIPMENT (See also Glass Working Machinery)
Amsler-Morton Co., Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Hartford-Empire Co., Hartford, Conn.
Lynch Corporation, Anderson, Ind.
Wm. J. Miller, Inc., Swissvale, Pa.

GLASSHOUSE TOOLS
Amsler-Morton Co., Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

GLASS PLANTS, COMPLETE INSTALLATIONS
Amsler-Morton Co., Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Hartford-Empire Co., Hartford, Conn.

GLASS WORKING MACHINERY
Automatic and Semi-Automatic Bottle Blowing, Electric Presses, Feeders, etc.
Bailey & Sharp Co., Hamburg, N. Y.
Hartford-Empire Co., Hartford, Conn.
Lynch Corporation, Anderson, Ind.
Wm. J. Miller, Inc., Swissvale, Pa.

GLORY HOLES, PORTABLE
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

HEATING SYSTEMS, HOT BLAST
The Kirk & Blum Mfg. Co., Cincinnati, O.

INSULATING BRICK, FURNACE AND BOILER
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

INSULATION, HEAT
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

KETTLES (all kinds)
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

LEHR LOADERS (See Automatic Conveyors and Lehr Loaders)

LEHRS
Electric
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Hartford-Empire Co., Hartford, Conn.
"Fireless", Automatic
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Muffle
Amsler-Morton Company, The, Pittsburgh, Pa
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Toledo Engineering Co., Inc., Toledo, O.

LEPIDOLITE
Drakenfeld, B. F., & Co., Inc., New York.

MACHINE SHOP SERVICE
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

MANGANESE
Drakenfeld, B. F., & Co., Inc., New York.

MIXERS, BATCH (See Batch Handling Systems)

MOLDS, MACHINE AND HAND
Wm. J. Miller, Inc., Swissvale, Pa.
Toledo Mould Co., Factories Bldg., Toledo, O.

OPACIFIERS
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.

POWDERED BLUE
Drakenfeld, B. F., & Co., Inc., New York.
Sharp-Schurtz Co., Lancaster, O.

POT CLAY
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

PRODUCER GAS PLANTS
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Wellman Engineering Co., Cleveland, O.

PYROMETERS, RECORDING and INDICATING
Dixon, H. L., Box 140, Pittsburgh, Pa.
Wilson-Maeulen Pyrometer Division, The Foxboro Co., Foxboro, Mass.

PYROMETER TUBES
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Wilson-Maeulen Pyrometer Division, The Foxboro Co., Foxboro, Mass.

REFRACTORIES (See also Fire Brick)
Glass House
Amsler-Morton Company, The, Pittsburgh, Pa.
Corhart Refractories Co., Louisville, Ky.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.
Laclede-Christy Clay Products Co., St. Louis, Mo.
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

REVERSING VALVES, GAS AND AIR
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

SALT CAKE
Drakenfeld & Co., Inc., B. F., New York.
Pennsylvania Salt Mfg. Co., Philadelphia, Pa.

SELENIUM
Drakenfeld, B. F., & Co., Inc., New York.

SHEET METAL WORK
The Kirk & Blum Mfg. Co., Cincinnati, O.

SODA ASH
Solvay Sales Corporation, Syracuse, N. Y.

SODIUM SELENITE
Drakenfeld, B. F., & Co., Inc., New York.

STORAGE BINS, RAW MATERIALS (See also Coal Handling and Storage Systems, and Batch Handling and Mixing Systems)
Amsler-Morton Company, The, Pittsburgh, Pa.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa.

TANK BLOCKS
Amsler-Morton Company, The, Pittsburgh, Pa
Corhart Refractories Co., Louisville, Ky.
Dixon, H. L., Co., Box 140, Pittsburgh, Pa
Laclede-Christy Clay Products Co., St. Louis, Mo.
Pittsburgh Plate Glass Co., Refractories Dept., Pittsburgh, Pa.

TANK FURNACES (See Furnaces)

URANIUM OXIDE
Drakenfeld, B. F., & Co., Inc., New York.

VENTILATING SYSTEMS
The Kirk & Blum Mfg. Co., Cincinnati, O.

WASTE HEAT RECLAIMING SYSTEMS
The Kirk & Blum Mfg. Co., Cincinnati, O.

WIND AND VENTILATING SYSTEMS
The Kirk & Blum Mfg. Co., Cincinnati, O.

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